Topographic Problems in the Cumberland Gap Area

Melvin Knolen Davis

TOPOGRAPHIC PROBLEMS IN THE CUMBERLAND GAP AREA

by

MELVIN KNOLEN DAVIS

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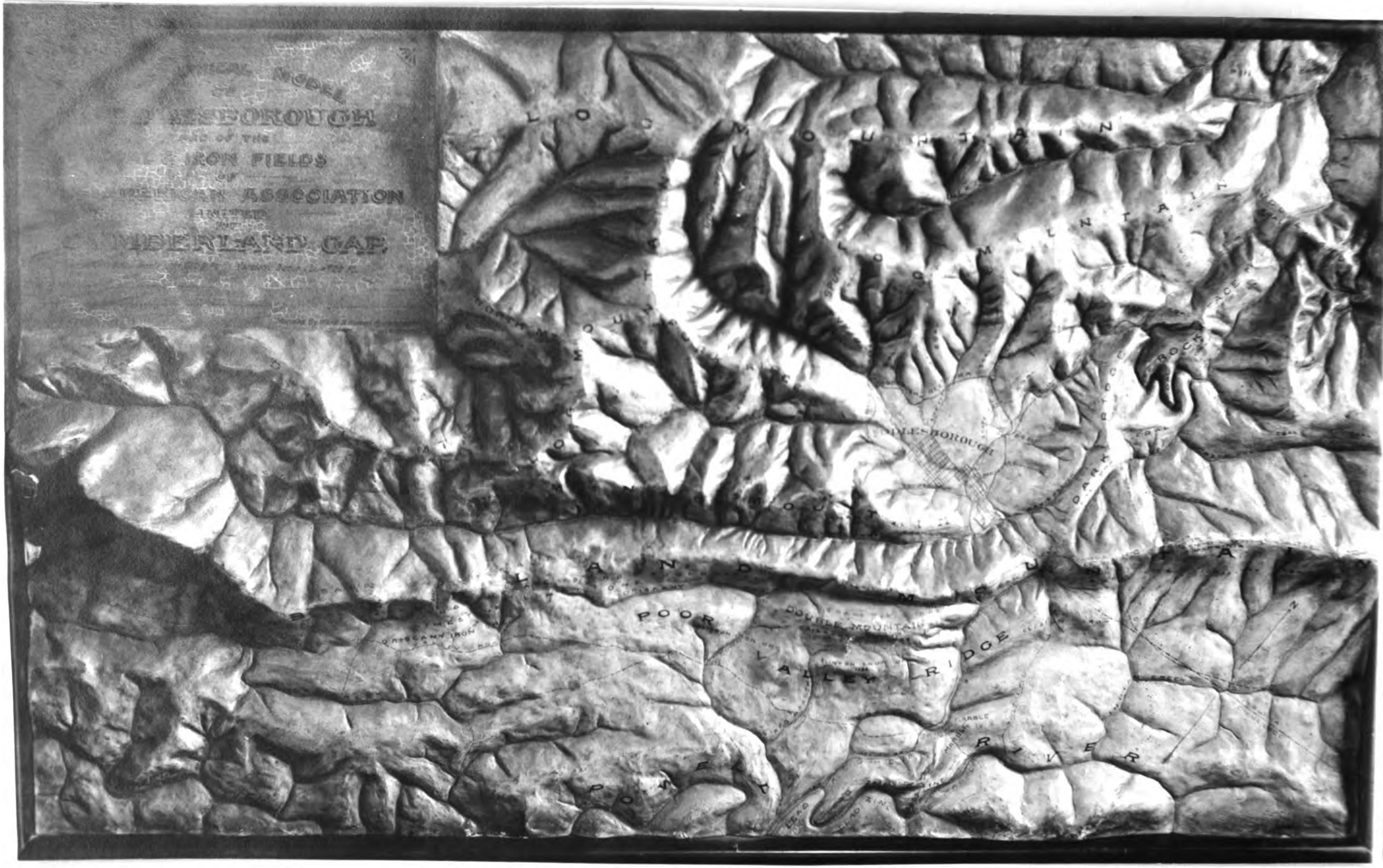

FRONTISPIECE

Outline of Southern Appalachian Provinces.

TOPOGRAPHIC PROBLEMS IN THE CUMBERLAND GAP AREA.

Outline.

TOPOGRAPHIC PROBLEMS IN THE CUMBERLAND GAP AREA.

INTRODUCTION.

Four topographic features will be explained in this article. (1) Cumberland Gap will be explained as to origin. (2) The valley of Yellow Creek in which Middlesboro, Kentucky, is located is singular in that the upper part of the valley is a very wide basin while the lower portion is a canyon. The canyon in its narrowest portion is very meandering. The basin, canyon, and meanders will be explained.

During the month of September, 1914, Professor H. H. Barrows of the University of Chicago took a class of twelve men, on a Geographical Survey, through the Cumberland Plateau and the Southern Appalachian Mountains. The writer was one of the students with Professor Barrows who directed our attention to geographical responses, chiefly, but in doing this, certain topographical and geological features had to be considered. Problems in topography and geology were not treated as such but were considered as influences, among other things, in the applied geography of the plateau and mountains of the Southern Highlands of the United States.

The problems in topography in the Cumberland Plateau are many and not a few are complex but the students who were interested in topographic problems were especially puzzled when they reached Pine Mountain and Cumberland Mountain. The water gap made by the Cumberland River through Pine Mount-

ain excited special attention and every one was alert as he went up the valley of Yellow Creek to the famous Cumberland Gap in Cumberland Mountains. Along this creek and at the latter gap is a region in which all the men became especially anxious for an explanation of topographic forms.

Before the class started on its field work the Department of Geography of the University furnished each student with references to reading material regarding the area that was investigated but none of these references give satisfactory answers to questions that arose during the few days we were in the Cumberland Gap area. Even though the class was allowed to give more time to this region than was usually given to other physiographic divisions each one went away unsatisfied because of a lack of answers to the questions that are here expressed in the land forms.

During the latter part of December of 1914 the writer went back to the Cumberland Gap district and gave a week to the study of the relief forms between Pine Mountain and Cumberland Mountain along a line which will most directly connect Cumberland Gap and Pineville Gap.

This essay is the result of the special investigations that have been given the Cumberland Gap area.

AREA DEFINED.

This thesis will not embody a treatise on the relief forms of the entire Southern Appalachians but it will be well to show the relation of the area under consideration to the general relief development in the southern division of the Appalachians.

By the title, Cumberland Gap Area, the writer does not wish to imply that this gap is in the center of the area in which he has been at work. In fact Cumberland Gap is near the southern edge of the region which extends from the gap northward about 15 miles to the Pineville Gap where the Cumberland River cuts through Pine Mountain. The positions of places may be seen from figures 1 and 2.

The line connecting Pineville Gap and Cumberland Gap is a north-south line and from this line, to the east or west, there are no features more than 10 miles distant which will be directly discussed in this paper.

STATEMENT OF THE PROBLEMS.

Cumberland Gap as a Topographic Problem.

The first feature to be considered is Cumberland Gap. Perhaps there is no one mountain pass in America so well known historically as this gap, but when the writer endeavored to find literature regarding it as a topographic feature, he found such literature very limited in amount and not nearly so specific as, for instance, the literature on the canyon of the Tennessee River in Walden Ridge.

The Middlesboro basin.

A casual observation of figure 2 will show that the level area upon which the town of Middlesboro is located is an exceptional feature in the dissected Cumberland Plateau. Figure 1 gives an idea of the size of the level basin-like area. The Belt Railroad circumscribes it in a general way yet the railroad in many places lies well within the periphery of the basin floor. It is called a basin because it is entirely surrounded by mountains except on the north where Yellow Creek flows through the mountains and joins Cumberland River 5 miles above Pineville. As regards the general shape of the Middlesboro basin a better idea can be had from figure 1 than from the topographic map. While the topographic map is good, it is generalized. The contour lines indicate that there is a grade of 200 feet and more per mile from the rim of the basin to Yellow Creek or its tributaries. This is not the case except where small and isolated hills stand up within the basin plain. Some of those isolated hills have a height that is within the contour interval but such hills are not shown on the Cumberland Gap Sheet, yet the hills must be noted and considered in the solution which is to explain the Middlesboro basin. This basin is almost circular and has an area of about 15 square miles. The floor, or the part that is inside of the Belt Railroad, appears almost level. This fact is shown by the pictures, figures 3 and 4, but the town is not on the best drained portion of the basin floor.

The floor is not residual material. It is transported material, but this would not be expected in a valley much of which is a canyon. The alluvium is much more extensive here than at any other place along the valley of Yellow Creek. No such alluvium deposits occur even along the Cumberland River which is many times larger than Yellow Creek.

The Middlesboro basin with its singularities constitutes another problem that is discussed in this paper.

The Canyon of Yellow Creek.

If one goes from Middlesboro to Pineville he will be surprised to find that the valley of Yellow Creek suddenly changes character near Excelsior where it becomes a canyon. From Excelsior to the mouth of Clear Creek the valley can be described in no other way than by saying it is a canyon but from Excelsior north for about 1 mile the valley is an extremely narrow canyon.

The Meandering of Yellow Creek at Rocky Face Mountain.

The great meanders of Yellow Creek near Rocky Face Mountain are features that are not seen elsewhere along the creek nor in neighboring streams. (See figure 7).

LITERATURE RELATIVE TO THE AREA.

In 1906 George H. Ashley and Leonidas C. Glenn published Professional Paper, No. 49, Cumberland Gap Coal Field, Kentucky. The field work for this paper was done between July 1 and September 20, 1902. The area discussed in this paper is nearly 90 miles long and 17 miles wide with Middlesboro at its center.

While Mr. Ashley and Mr. Glenn are not to be held responsible for a detailed solution of topographic features, they raised several questions for which they gave fairly satisfactory solutions, and their descriptions of formations are good with the exception of vertical location which they themselves say, "In cases of such disagreement a compromise has often been necessary in showing the location of a coal on the map, though usually the attempt was made to show its horizontal position rather than its position relative to surface contours, as it is believed that such procedure would best meet the needs of the engineer in the field." (A parenthetical statement might be made that the engineers are keenly concerned in vertical locations and for that reason elevations should have been made correctly.) The chief purpose of the excellent paper is the horizontal location and description of coal and coal measures.

Another paper which is very excellent was written by C. W. Hayes and entitled Physiography of the Chattanooga District. This article which is in the 19th Annual Report of the

United States Geological Survey, Part II, deals specifically with the geomorphology and the geomorphogeny of an area about 14,000 square miles in extent and of which Chattanooga is the center.

In so much as the Cumberland Gap area is in one of the five great topographic provinces that cross the "Chattanooga District" the report of Mr. Hayes is very helpful, especially in the correlation of physiographic sub-divisions of the Southern Appalachians.

In the National Geographic Magazine, Volume 6, Messrs. C. W. Hayes and Marius R. Campbell have an article which deals with "Geomorphology of the Southern Appalachians". This classical work bears only indirectly on the problems that are to be dealt with here.

In order to show the nature of the report by Messrs. Hayes and Campbell a paragraph of theirs is quoted.

"In the southern Appalachian province the more or less perfectly preserved remnants of two base-leveled peneplains have been mapped and their deformations represented by contours; the conditions implied by these base-levels have been inferred; their probable correlations with contemporaneous sedimentary deposits indicated; and finally the development of the drainage has been traced through a complex series of adjustments upon the repeatedly deformed surface to its present mature location."

The reconstruction of peneplains have helped the writer of this paper much in the solution of the problems involved.

All of these references are very good in showing the general relationships of physiographic conditions in the Southern Appalachian Mountains but none of them offer solutions for the problems that are mentioned above, namely, Cumberland Gap, Middlesboro basin, the canyon of Yellow Creek, and the meandering of Yellow Creek in Rocky Face Mountain.

DIVISIONS OF THE APPALACHIAN HIGHLAND.

The examination of a topographic map or of a model of the Appalachian system will readily show that there are three very well-defined physiographic divisions in those mountains. Throughout each division sedimentation, orogenic movements, and denudation have had almost the same effects, so that the geological elements coincide with the topographic divisions.

The central Appalachian province is a valley. In this valley lie the Coosa, Tennessee, Shenandoah, and Cumberland Rivers. The name which is applied to this lowland, which has a width of from 40 to 120 miles, is "Appalachian Valley". *

West of the Great Valley lies the dissected Cumberland Plateau; to the east of the Great Valley is the narrow belt of mountains, known as the Crystalline Appalachians or

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* Note: In Georgia the Appalachian Valley is known as the Coosa Valley; in Alabama and Tennessee, the Great Valley of East Tennessee; it is the Shenandoah Valley of Virginia, and in Maryland and Pennsylvania it is the Cumberland and Lebanon Valleys.

Older Appalachians.

These topographic divisions are mentioned in order to show the general relationships of the Cumberland Plateau to the rest of the topographic divisions of the Appalachian highlands, because the features that were studied are located on the eastern edge of Cumberland Plateau.

GEOLOGY OF CUMBERLAND GAP AREA.

The rock formations of any area will be a factor in determining relief forms. For this reason something is said of the bed rock. The stratigraphy of this area and the sequence of geological events are not such difficult problems as in the Crystalline Appalachians or in the Piedmont Plateau. While some geologists in the mapping of the orographic elements of the United States put the Cumberland Mountains into the Appalachian province, these mountains can easily be used as the east boundary of the Cumberland Plateau. The Cumberlands are the up-turned edges of the sedimentary formations which constitute the bed rock of this plateau. So it will be seen that the geology of this area will have characteristics of the Interior Plains. The kind of rocks as well as their attitude will influence the agents of erosion in determining relief. In order that this may be considered, geological formations with their lithology and structure are given below.

If the map of the United States were divided in such a manner as to show the larger geological provinces, Cumber-

land Plateau and Cumberland Mountains would fall into the division which includes the Central Plains because the plateau includes the same large geological formations which, speaking in general terms, have not been greatly disturbed; but the Cumberland Mountains which lie at the eastern side of the plateau are the up-turned beds of rock which underlie the plateau and much of Central Plain to the west.

The rocks which crop out in the Cumberland Gap area are of Carboniferous age and consist chiefly of sandstones, shales, and limestone with several beds of coal. The limestone crops out only on the east side of the Cumberland chain. Here half, or more than half, of the Carboniferous sediments is shales and the column is about 4000 feet thick.

CLIMATE OF THE AREA.

In a discussion which embodies a treatise of land forms, climate is not to be overlooked. An arid region will have obtaining in it relief forms that are different in many respects from those in a humid region, -- e. g., near San Bernardino are great alluvial fans, many of which have radii of from 10 to 15 miles and their heads have an elevation of as much as 500 feet above the outer termini.

Periods of low temperature are evidenced, often, by glaciation.

It may be that climatic factors have been different, in different geological periods, in the Cumberland region but there is no evidence of a recent change. One can say,

safely it seems, that the climate which prevails there now has been quite constant since the close of the Permian period. There were, perhaps, changes during and after Pleistocene times.

The climate is the moist, temperate type with an annual average temperature of 60° Fahrenheit; an annual range of 30 degrees, and a rainfall of 60-75 inches.

GENERAL PHYSIOGRAPHY OF CUMBERLAND PLATEAU.

This is an area of 37,500 square miles in eastern Kentucky, eastern Tennessee, the northern part of Georgia, western Virginia, and southern part of West Virginia. The eastern boundary of the plateau is the Great Valley of Eastern Tennessee. On the west, Cumberland Plateau is bordered by a plain of rather low relief, the northern part of which is known as the Blue Grass Country.

The strata of sandstones, shales, and limestones of Cumberland Mountains dip steeply to the west but immediately west of the eastern escarpment which faces The Great Valley the strata become almost horizontal, but retain a slight dip to the west and south.

This area has been described above as a dissected plateau and while this would be the best single word by which to describe this plateau region it has several flat-topped areas, especially in the southern part; e. g., Waldon Ridge.

From the general dip of the strata and from the appearance of those large mesa-like areas one might decide that the level surface of the mesas and the structure of the strata are parallel, but it has been noticed that the surface of the plateau in many places cuts across synclines and other mountain structures. From these relationships of surfaces and structure and from the fact that the Carboniferous rocks are everywhere the last formation in the geological sequence, one may infer that Cumberland Plateau after being lifted far above sea-level and slightly folded, (perhaps in Permian times), was reduced to a peneplain. This peneplain is known as the Cretaceous peneplain.

After the planation of the Cretaceous period was quite complete there was a second uplift and a rather incomplete peneplanation which is referred to as Tertiary. Both peneplains are not highly characteristic features throughout the plateau but are found especially in the southern part.

Later, perhaps in late Tertiary times, there were other upward movements of the region. These were not great, but sufficient to rejuvenate the streams which have, at present, the plateau developed into the mature stage of the erosion cycle.

These statements are to give the general features and factors in the development of Cumberland Plateau which rises in elevation from 500 feet in the south to more than 3000 feet in southern West Virginia. The Cumberland Gap area is a small section of Cumberland Plateau. It has not only the

general characteristics of the plateau but some special features which are to be subsequently discussed.

Cumberland Gap's place in this physiography.

The location of Cumberland Gap is well given when it is said to be at the so-called "three corners" of Virginia, Kentucky and Tennessee. This gap is perhaps the most striking feature of the topography of this region. Figure 5 shows the gap from the Great Valley side. The floor of the gap has an elevation of 1649 feet above the sea while the pinnacle to the east (to the right in figure 5) has an altitude of 2510 feet.

The problem here is how was a gap of such magnitude formed?

THE FORMATION OF WIND AND WATER GAPS.

Gaps by Glaciation.

Gaps of somewhat similar character may be formed by glaciation. The headward erosion in a cirque on either side of a divide would result in a through valley, but this is not to be considered in an explanation of Cumberland Gap because of climatic conditions which have already been mentioned and because of the lack of glacial features throughout the Southern Appalachian Highlands.

Headward Erosion by Rivers.

Headward erosion by rivers may result in a mountain gap. Hayes and Campbell account for the gorge of the Tennessee River through Waldon Ridge by a phase of this process. The full application of their hypothesis could not be made at Cumberland Gap because there is not a stream flowing through the gap at the present time but two small streams flowing in opposite directions from the crest of Cumberland Mountain could find a weakness in the rocks and erode a gap. By this process erosional functions of each stream would have to be the same. Otherwise one stream would work headward faster than the other. This would cause the highest portion of the floor of the gap to be at one side of the linear crest line of the Cumberland Mountain chain. After investigating this point, it was found that the lower part of the gap is in line with the general crest of the mountains. It hardly seems possible that the work of streams on opposite sides of a mountain could be so evenly balanced. Granting that each had the same rainfall the stream on the south side has an average fall of 67 feet per mile while the stream on the north side of the mountain has a fall of 176 feet per mile to reach the same elevation, or its master stream.

As each of these very small streams has a master stream that is able to carry away all the load it can bring, it appears that the erosional functions of the little inter-

mittent streams flowing either way from the gap are not balanced. From these conditions it is safe to conclude that Cumberland Gap is not the product of headward erosion of small streams even though intermittent streams have their sources in the gap now.

The Cave Hypothesis.

Cumberland Gap is in the escarpment side of a cuesta. The rock of the cuesta are sandstone, shale, and limestone (see Figure 5). Near the base of the escarpment is a band of limestone which has a thickness of about 300 feet. In this limestone and in the east side of the gap is an enormous cave. The work that is going on in this large cave is not unlike that in other caves in limestone. Solution is rapidly carrying away the great limestone bed. As has been stated, the limestone is near the base of the escarpment so that when it is more thoroughly removed higher formations will fall. This will certainly make the gap in the escarpment larger. Of course, there are other points to be considered in this hypothesis. If similar erosion has taken place at the gap, one might expect to find remains of such in the form of talus blocks of a different character than elsewhere along the foot of the escarpment. This does not prove to be the case. While there are great numbers of boulders on the south side of the gap, they can be accounted for by the erosion that is now active in the gap.

From another consideration it would seem to be an adjustment, entirely too nice, that the mouth of the cave on the east side of the gap should have always coincided with the gap wall. If the gap is due to cave development, there should be some traces of the cave on the west side of the gap, but there are none.

It should be mentioned that, so far as the writer knows, none of the other gaps in Cumberland Mountains bear such relations to caves.

Stream Hypothesis for Cumberland Gap and Neighboring Gaps.

Upon looking at a map one feels as if Cumberland Gap can be accounted for by stream erosion and when one views the gap itself, it is very easy to think of a great stream that once flowed through it.

When the writer went into the field to work on the topography, he had in mind the stream erosion hypothesis and the statement made by G. H. Ashley and L. C. Glenn in which they say, "It has been suggested that the stream which began the notching that resulted in the Pineville Gap may also have cut a notch in Cumberland Mountain at Cumberland Gap".

Pineville Gap is a water gap in Pine Mountain 15 miles north of Cumberland Gap. It is occupied and maintained by Cumberland River the elevation of which, in the gap, is 1020 feet above sea level. Pine Mountain on either

side of this gap has an elevation of 2500 feet.

If a stream once flowed through Cumberland Gap it was at a time when this area was in a different stage of the erosion cycle from the one in which it is now, and as the Cretaceous peneplain has been well established for the Southern Appalachian region let it be assumed, with a high degree of certainty, that in Cretaceous times an erosional plain occupied this area. Over this area were systems of streams flowing over rocks, quite independently of the rock structures. This condition surely existed. Then the mountain building force was applied again and the peneplain became an upland into which streams cut.

Many cases of stream adjustment can be shown in the Appalachian Mountains; many wind gaps were once water gaps and at present there are water gaps in Cumberland Mountain chain. Only 41 miles northeast of Cumberland Gap is a small branch of Powell River which flows southward through Cumberland Mountain and 30 miles to the southwest Big Creek flows through in the same direction.

If Cumberland Gap was once the site of a stream such as the branch of Powell River at Pennington Gap or Big Creek at Big Creek Gap, what has become of the stream and in what ways would a stream at Cumberland Gap be different from a stream at either of the other places? If conditions at the gap were once different some trace of such difference or results of such differences would be likely to remain. Fig. 6 shows Cumberland Mountain, the crest of which is the boundary between Kentucky

and Virginia. Six miles southwest of Pennington Gap the boundary turns to the north and follows a mountain chain which has an elevation of from 2000 to 3200 feet, while the elevation of the chain in which the branch of Powell has cut Pennington Gap has elevations ranging from a little less than 2000 to 2800 feet.

This indicates that this branch of Powell River is still consequent upon a course given to it at the time of the uplift of the peneplain. A reconstruction of the peneplain will also show that no divides, or streams, have here been shifted to any extent. The reconstruction of the peneplain is to be mentioned and explained later.

What is the case at Big Creek Gap 30 miles to the southwest of Cumberland Gap? Here Big Creek has a gap in Cumberland Mountain. The floor of this gap is 1200 feet above sea level or 449 below the floor of Cumberland Gap.

After passing through the gap to the south, Big Creek empties into Clinch River. The two streams, Big Creek and Powell Branch, are similar in another attribute. Each is a short stream, on the north side of its gap. In other words, short streams are maintaining Big Creek and Pennington Gaps as water gaps. Big Creek is 6½ miles long between its source and the gap.

The shape of Big Creek valley above the gap indicates that much of the valley has been made by headward erosion. It is narrow above the gap, and above grade, with a fall of 49

feet per mile in the two miles immediately north of the gap. The gradient farther up the stream is much greater but it was not determined.

Cumberland Mountain is low and less definite here than farther to the northeast. This means that a stream would have less work to maintain its antecedency than a stream in the higher portions of the mountains.

Again, Clinch River, which is 9 miles south of Big Creek Gap, is only 940 feet above sea level. This is the lowest local base-level that any stream draining the escarpment of Cumberland Mountains has at present. This comparatively low local base-level aids streams in their headward erosion and maintenance of antecedent courses.

The writer considers Big Creek as an antecedent stream in its course across the ill-defined southern end of Cumberland Mountains.

Childer Gap and Wilson Gap which are between Big Creek Gap and Cumberland Gap and have elevations of 2200 and 2150 feet are hardly to be considered as gaps but rather as sags in the crest line of the mountains which here have about the same elevation as these gaps.

If streams once went through these gaps or through Butcher Gap which is 8 miles east of Cumberland Gap and which has an elevation of 3000 feet, such streams were very likely tributaries to a larger stream that flowed through Cumberland Gap.

The Hypothesis that employs Faulting applied to Cumberland Gap.

One of the most obvious things in Cumberland Gap is faulting. It is noticed immediately when the observer reaches the south end of the gap. On the west wall of the gap near the top the rocks are sandstone and conglomerate which dip N. 50° W. The angle of dip is 27°. The top of the Newman limestone crops out at the foot of the escarpment on the west side of the gap. (See Figure 5). On the east side of the gap the Newman limestone is found at an elevation of 1730 feet or about 78 feet above the floor of the gap. These beds here dip N. 4° E. and have an angle of 44° in dip. These observations were made in and near the gap so that the figures are not to be applied to other parts of the escarpment.

The breccia which may be found along a line which closely follows the railroad is another evidence of faulting, and the breccia blocks show a second breaking and cementation. This may be the same fault that is found on the west side of Rocky Face Mountain. (See Figure 7).

The peneplain was developed after the faulting, even though there were two periods in which faulting occurred because of similar altitudes on either side of the gap and Rocky Face Mountain is of the same general altitude as Cumberland Mountains.

The faulting took place before the development of the Cretaceous peneplain so it seems that a stream would have be-

come adjusted to the fault or line of broken rock in the development of the peneplain.

THE CUMBERLAND GAP RIVER.

In the south part of the gap are many quartzitic boulders. They rest on the floor of the gap. Their hardness is 7 and they were examined for evidences of stream action. The best evidence found upon them was pot holes, or what the writer thought might be pot holes, although he is in doubt because the sandstone in the Lee formation has in it pockets of iron oxide which weather out. But the Lee formation is better described as conglomerate while the sandstone boulders on the floor of the gap are fine grained and are from the hard sandstone that is 82 feet above the saddle of the gap on the east side and on a level with the saddle on the west side. No pockets of iron ore were found in this sandstone.

This was followed by further investigations which were to show whether or not a stream had ever occupied the gap. The following method was employed. Field work was done to find evidences of the stream north and south of the gap.

In regard to this phase of the work, Messrs. Ashley and Glenn in Professional Paper 49, say: "There is room here for only the barest mention of this subject, which is of special interest because of its relation to the origin of the water gap at Pineville and other features in the Cumberland Gap area. Whatever the original direction of the drainage that developed after the great uplift of the Appalachian prov-

ince, it seems probable that before the end of the long period of erosion resulting in the Cumberland peneplain, Cretaceous peneplain, the central part of the Appalachian province was drained northwestward toward the Ohio Valley. It has been thought that New River and many of the eastern tributaries of the Tennessee are parts of the old drainage system that have persisted. It has been suggested that a stream, of which the French Broad River of western North Carolina may have been one of the head tributaries, rose in the eastern Appalachian Mountains and flowed northwestward toward the Ohio, crossing the eastern part of what is now the Cumberland Plateau in the vicinity of Pineville."

This information is very useful but the facts were not as specific as the writer needed to satisfy himself that a stream at one time did or did not flow through Cumberland Gap.

There are two things that can be said regarding a river that flowed through Cumberland Gap, if one once flowed through. (1) If the stream flowed through the gap toward the west as suggested in the above quotation, the evidences of such a stream are very remote. (2) There is no means by which to prove that a stream flowed through the gap before the deformation of the Cretaceous peneplain.

If a stream ever flowed in the opposite direction there is at least one way by which it may be shown.

It has been mentioned that the Lee formation is a conglomerate. It contains hundreds of quartz pebbles to the cubic foot. The pebbles are sharply characterized by their

whiteness and size, being about 1/4 to 1/2 inch in diameter. This formation breaks down easily. It is used for sand and gravel. There is a quarry on the mountain west of the gap where the high tension wires cross the divide. Here the sandstone is broken with hammers, screened, and separated into sand and gravel.

If a stream once went through the gap it carried from it sand and gravel of the Lee formation.

When the stream was upon the Cretaceous peneplain and was flowing westward as is suggested in the quotation above, it surely carried gravel out over the old and truncated surface so that the old river site may be located. Portions of the peneplain lie between Cumberland Mountain and Pineville Gap but to find river gravels here would not show in which direction the river was flowing because Pine Mountain is capped by the Lee conglomerate as well as Rocky Face Mountain. Besides, the area between Cumberland and Pine Mountains is a flat syncline into which the weathered conglomerate could be washed from either side.

The beds of quartz pebbles on the remnants of the peneplain north of Pine Mountain can be accounted for by the Cumberland River so they are not to be considered.

Three miles and more to the south of Cumberland Gap can be seen a chain of hills that appear to have the elevation of the gap. (See frontispiece).

The gap lies at 1649 feet, while the chain of ridges range from 1375 to about 1600 feet above the sea. Those hills are shales and limestones of an entirely different geological province. They are in the Great Valley Region. The Poor Valley Ridge is what remains of the Cretaceous peneplain in this particular region. If a stream once flowed from Cumberland Mountain southward it was at a time when The Great Valley region was at about the elevation of the gap. As Poor Valley Ridge and Double Mountain are now the remains of that former plain, they were examined for the quartz pebbles or gravels that should have been washed from the soft Lee conglomerate at Cumberland Mountain.

The extremely heavy rains during the time, a little more than a day, that was given to this work prevented a thorough investigation of Double Mountain.

Poor Valley Ridge was investigated rather thoroughly. The heavy rain was in one respect an advantage after the crest of the ridge was reached. It had the higher and less protected parts swept clean. In those clean areas were found a few gravels that are of the kind that are contained in the Lee conglomerate. The number found in those places was strongly suggestive. How were they brought to Poor Valley Ridge? They are not in the shale and limestone of the ridge.

The quartz gravels were found in one well protected location which was on one of the higher portions of Poor Valley Ridge about 3½ miles south of Cumberland Gap. The hill is covered with forest but the place was being used as a feeding

ground for hogs. Here many of the white quartzite pebbles were found.

They indicate that a stream once flowed southward from Cumberland Mountain where such gravels are found in place. This stream existed when the area between Poor Valley Ridge and the gap was as high as the ridge.

There is another means by which the gravels could be left upon the hills south of the gap. The Cumberland escarpment may have extended farther south. At such a time the gravels could have been brought immediately down upon the hills which were then at the foot of the escarpment. But it does not appear that the escarpment has retreated so much as this would indicate.

The Cumberland escarpment has not retreated from the neighborhood of Poor Valley ridge. Rocky Face Mountain is similar in every attribute, except length, to Cumberland Mountains and it is known that Rocky Face has been weathered back but a very short distance from its fault line.

After a consideration of these facts is seems that the gravels on Poor Valley Ridge were brought there by a stream which flowed southward from Cumberland Mountain. This does not mean that they were deposited by a stream which flowed through Cumberland Gap but it does mean that they were carried there by some stream, or its tributaries, which flowed from the mountains southward.

The reason for mentioning tributaries at this point is because of the fact that to the northeast and southwest of

Cumberland Gap there are several smaller gaps in Cumberland Mountain chain.

These facts do not disprove that a stream never flowed across Cumberland Mountain toward the west. Such may have been the case but conditions which would prove this are so remote that anything offered at this time would be purely a matter of conjecture.

The writer thinks that Cumberland Gap has had very little, if any, relation to such an ancient river as the one mentioned in the above quotation and as there is no way of showing that such a river ever existed, attention will be given to the relationship which existed between Cumberland Gap and a younger stream.

As was stated above, there are not enough data at hand now to show definitely how the streams flowed upon the Cretaceous peneplain because the old erosional plain has been elevated and "deformed". When the peneplain was reconstructed by Messrs. Hayes and Campbell in their excellent work on the "Geomorphology of the Southern Appalachians" it was shown that the central part of the plain was raised to a greater elevation than the areas on either side. A part of one of the maps from the "Geomorphology of the Southern Appalachians" is represented in figure 8. The contour lines show the relative heights of different portions of rejuvenated plain of which only remnants now remain. Line E-F shows the central axis that existed after the uplift of the peneplain if such an axis did not exist before the uplift.

By following this line it will be noticed that it passes about 4 miles west of Cumberland Gap.

Across this crest line of the peneplain now flow the Tennessee in the southern part of the plateau, some large tributaries of the Kanawha system in the north, and some very small tributaries of the Cumberland River and the Powell-Clinch system.

The two facts, location of gravels as mentioned above and the location of the crest line of the Cretaceous peneplain which had been determined before the writer went into the field, are very indicative that, immediately after the deformation of the peneplain, streams flowed from the crest toward the south. The courses of such streams have been changed somewhat because of the nature of the underlying rocks which are chiefly limestones. The water that now is shed from the east of the crest line is concentrated into the Powell, Clinch and Holston Rivers.

In some sections of the crest line streams have either been able to remain as antecedent to the line or have crossed it by headward erosion, both of which cases are possible and seem to be illustrated along the central ridge of the rejuvenated peneplain.

The larger streams surely kept their courses and because antecedent upon the crest line while smaller streams were diverted. This means that no very large stream ever flowed through Cumberland Gap. The stream that once occupied the gap was too small to maintain its course across the crest line.

Another fact shows that large rivers have not recently

occupied a position near Cumberland Gap. Along the crest line and in the region of the gap are extensive areas of rock that reach several hundred feet above the Cretaceous peneplain. They may be thought of as monadnocks upon the peneplain. There are similar monadnock-like areas elsewhere along the crest line but at no place are they so great in area as in the Cumberland Gap field. If a large river had once been in this region, either in Cretaceous or post-Cretaceous times, one would expect such areas to be worn to a lower level and reduced in extent and if a large river was once here it would have kept its course, as the large rivers, in other portions of the uplifted plain, have done.

VALLEY OF YELLOW CREEK ABOVE ROCKY FACE MOUNTAIN AND THE EXPLANATION OF CUMBERLAND GAP.

Figure 7 shows that the valley of Yellow Creek is singular because of the fact that from Excelsior northward it is a canyon while from Excelsior upstream for 7 miles the valley is wide and the floor is an extensive sheet of alluvium. This difference cannot be due to differences in kinds of rock. The rocks between Cumberland and Pine Mountains are the almost horizontal beds of Carboniferous age. Rocky Face is the only striking example of highly tilted beds. The problem here is to account for the gorge of Yellow Creek near Rocky Face Mountain and for the "basin" in which the town of Middlesboro is located. The alluvium which is discussed in Professional Paper 49 is also to be accounted for.

The Middlesboro Basin.

Attention has already been called to the fact that when the Cretaceous peneplain was deformed,a plateau of which all parts were the same height was not the result. Instead there was a major crest line as is shown in figure 8. This line passes between Cumberland Gap and Cumberland River. That line at the time during the uplift became the divide between streams flowing south and those flowing into Cumberland River. By the heights of peaks between Cumberland and Pine Mountains and by the manner in which Rocky Face has been faulted and has had eroded from it 2000 feet of sediments, it is safe to locate the crest line at the south end of Rocky Face Mountain.

While the crest line was the divide between the tributaries of Cumberland River and those that went southward, the waters that were drained from the Middlesboro Area went southward; and as Cumberland Gap is the lowest notch in the rim of the basin, excepting the present outlet, it will be assumed that the water from the basin was discharged through it when the floor of the basin was at the level of the saddle of the gap, or higher.

The part of the floor that had the level of Cumberland Gap should remain, not at exactly that elevation because of the differences in hardness in the shales, thin sandstones, and coal beds of the basin area and the sandstones and limestpnes at the gap. The shales in the basin are weathered and eroded rapidly.

Immediately north of the gap are two isolated hills that have an elevation of 1640 feet; in figure 8 are two flat-topped hills represented between the gap and Davis Branch. These have elevations of 1600 and 1640 feet. North of Davis Branch is a dome-shaped hill which rises to 1540 feet. Farther out in the basin the old basin floor has been more thoroughly dissected and the hills are showing the characteristics of the new "local base-level of erosion". In other words the hills are lower near Yellow Creek and become higher farther away from the stream. This is well shown in the picture, figure 9. In the foreground near the larger stream may be seen the lower hills while farther away are the hills that have not been influenced so greatly by erosion. There are many dome-shaped hills that rise, in the basin, to a height of about 1300 feet. While this height is 346 feet below the saddle of Cumberland Gap, it is a difference that is easily accounted for by the hardness of the strata and the distance from the main stream.

Little has been said of the size of Middlesboro basin. So much of the old floor has been reduced to the well-rounded hills, the elevations of which are from 1300 to 1600 feet, that a low contour will be considered as the boundary of the basin; e. g., 1400 feet. At this elevation the diameter of the basin is near 4½ miles and the area about 15 square miles.

While the streams in this area flowed out at Cumberland Gap (see Figure 10), the gap was their local base-level. The basin was small and consequently no great stream was at work in the gap. The gap was cut slowly for two reasons. The

stream flowing through it was small and the sandstone and limestones in the gap are much harder than the rocks in Middlesboro basin. This fact would result in the formation of a basin.

While the main stream, made up of the tributaries of the basin, was slowly cutting a gap across Cumberland Mountains, the tributaries became graded and as the main stream was too weak for its work in the gap the tributaries not only became graded but old, meandering upon their valley floors, widening their valleys greatly. Those widened valleys are now represented by a basin which has been subsequently greatly modified. It is obvious that the present floor of the basin is much lower than Cumberland Gap and that the old floor is greatly dissected.

DIVERSION OF MIDDLESBORO BASIN DRAINAGE. In discussing this topic it will be well to start again with the crest line of the Cumberland or Cretaceous peneplain. It has been located but it might be said that it passes somewhere near the north margin of the Middlesboro basin.

While the uprising of the area was producing this crest in the peneplain and for some time after the line was, as stated above, the divide between the Cumberland River and a smaller stream that flowed through Cumberland Gap from the Middlesboro basin.

The Middlesboro basin is now drained to the Cumberland River by Yellow Creek (see figure 11). What conditions made it possible for a tributary of Cumberland River to cut through the north rim of what is now Middlesboro basin and divert the

drainage of it from its crossing at Cumberland Mountain?

Pine and Cumberland Mountains are very similar. They are near the same altitude and are constituted of the same strata. This may be seen in figure 7. During the uplift of the Cumberland peneplain, Cumberland River which was on the north and west side of the crest maintained its course across Pine Mountain, which course it occupies today. Cumberland River is a large stream. It was strong enough to cut its gap in Pine Mountain much faster than the small stream that commenced to maintain Cumberland Gap as a water gap. Because of the fact that a gap in Pine Mountain became so much lower than the gap in Cumberland Mountain the tributaries of Cumberland River were able to do much headward erosion and deepening of their valleys. The headward erosion resulted in the tapping of the Middlesboro basin by the lower portion of what is now Yellow Creek. That creek in its headward lengthening reached the southward draining basin near the place where the station of Excelsior was located. As one goes north from Middlesboro it is here that he realizes that the limit of the basin has been reached. From Excelsior a true canyon extends northward for about a mile. It is here that the rate of flow of Yellow Creek changes. From Excelsior southward through Middlesboro and westward, Yellow Creek has a fall of 1.9 feet per mile; below Excelsior the fall is more than 16 feet per mile.

From this it is seen that above the gorge of capture the valley is graded while in the gorge and below the valley

is not graded.

The two points in this section are (1) the diversion of the Middlesboro basin drainage, and (2) that when this diversion took place Cumberland Gap became a wing gap.

THE ALLUVIUM IN THE MIDDLESBORO BASIN. The extent of the alluvium on the floor of the Middlesboro basin is shown in figure 7. The data regarding the depths of the alluvium were secured from W. C. Richardson who has been city engineer of Middlesboro for 28 years. According to this information the alluvium is thickest, 30 feet, where the corporation line (Figure 7) crosses Bennett Fork. Near the railroad yards, especially, and in other parts of the town, cellars and basements reached bed rock. From Bennett Fork, where the alluvium appears in the greatest thickness, northward to Rocky Face Mountain, the valley filling continues to grow thinner and comes to an end a short distance below Excelsior. Between Excelsior Mine and Rocky Face Mountain there is a very small amount of alluvium.

Theories Regarding the Alluvium. In Professional Paper 49 are two theories which account for the sheet of alluvium in Middlesboro basin. According to the first theory presented there, the alluvium is assumed to be very deep and a stream had a valley cut in the bed rock to the level at which the bottom of the alluvium now is. Then the outlet of the basin rose and the valley was partially filled with alluvium. Subsequent down-cutting of the outlet has since determined the height of the floor.

"According to the second hypothesis the development would have been thus: (a) Erosion down to upper gradation or Arthur Heights plain; lowering of outlet to allow lowest erosion; elevation of outlet to present position."

These hypotheses are very good if no better explanation can be given but they are not applicable when one commences field work in the area.

<u>The Alluvium accounted for.</u> The elevation of the edge of the alluvium just west of Rocky Face Mountain is 1120 feet; the level of it where the corporation line crosses Bennett Fork is 1170 feet. The thickest alluvium (30 feet) was found here.

When 30 feet are subtracted from 1170, it shows that the elevation of the solid rock floor of the valley at this place is 20 feet above the present rock floor outlet of the basin. This means that the bed of the basin has at no time been lower than the outlet.

The 20 feet which represents the fall from the crossing of Bennett Fork and the corporation line to the lower end of the alluvial plain gives a fall of 2 feet per mile. The fall in the present stream between these points is about 1.9 feet per mile.

These are the conditions by which the alluvium is to be explained. Not only does the great flood plain deposit itself have to be accounted for but the fact that it is a thicker deposit in the upper portion of the valley than in the lower also needs explanation.

When the drainage was diverted to the north the local base-level for the Middlesboro basin was Cumberland River but if there were bands of comparatively harder rock between the basin and the river those rocks would act as a base-level and determine to what extent the valley above them would be cut down.

The harder rocks at Rocky Face Mountain make such a base-level for the basin. The rocks in the gorge at the south end of this mountain are known as the Lee conglomerate, which is harder than the shales which constitute the bed rock of the greater portion of Yellow Creek Valley. While Yellow Creek has been cutting to lower and lower levels its new outlet near Rocky Face Mountain has, because of hard bands of rock, been able to cut it fast enough to prevent the stream above the region of capture from becoming old. That is, the stream in the portion of the valley known as the Middlesboro basin has been able to grade its valley, become meandering, and aggrading. The meandering resulted in the wide floor and the aggrading has resulted in the alluvial floor.

As the alluvium is not a very thick deposit and the meander belt, before the canalization of Yellow Creek, was as wide as the alluvial plain, the alluvium can easily be the work of Yellow Creek as an aggrading stream.

The thick portions of alluvium are near the mouths of the tributaries which are able to carry more load than Yellow Creek. When those streams join Yellow Creek there is a heavy and sudden deposition of sediment.

There is a differance in the slope of the alluvium where the tributaries join the main stream. The slope in areas farther from the tributaries is much more gentle than where the tributaries join. This is shown by figure 12 which represents an area near a tributary and figure 13 which shows an area farther away from a tributary.

The piling up of the material by tributaries near their mouths is the cause of the greater thickness of the alluvium there; e. g., where the corporation line crosses Bennett Fork.

THE MEANDERING OF YELLOW CREEK AT ROCKY FACE MOUNTAIN.

This problem is another that is related to the Cretaceous peneplain. The crest line of the warped peneplain was at the south end of Rocky Face Mountain, as indicated above.

The lower course of Yellow Creek, during the time that the peneplain was rising and later, had its head at the crest line of the deformed Cretaceous peneplain. In flowing toward Cumberland River it crossed the part of the peneplain that later became Rocky Face Mountain. While on the peneplain this short tributary, Yellow Creek, was necessarily a meandering stream. This characteristic the stream has retained by entrenchment in the hard rock of Rocky Face Mountain.

The reader may ask what has become of the meanders of similar meandering streams in this region.

Other streams here are in much softer rock than the rock where Yellow Creek is meandering. Therefore such old meanders have been cut away elsewhere because of the soft rock material.

CONCLUSIONS.

Cumberland Gap is due to stream erosion. Figure 10 shows the drainage that once went through the gap. Figure 11 shows the present drainage of Yellow Creek which flows northward, from its sharp turn, to Cumberland River. The cause of Yellow Creek was changed by a capture.

Cumberland River is a larger stream than Yellow Creek. Cumberland River cut down more rapidly in Pine Mountain than Yellow Creek did in Cumberland Mountain. This resulted in the capture of Yellow Creek by a tributary of Cumberland River. After the diversion of Yellow Creek, Cumberland Gap became a wind gap and has remained as such to the present.

Middlesboro Basin is shown in Figure 7. This basin is the upper portion of the valley of Yellow Creek. This portion of the valley is much wider than the section of the valley at Rocky Face Mountain and immediately above. These conditions are due to the fact that the basin was an old and well graded valley before the gorge just above Rocky Face Mountain was cut. The south part of the gorge through which the water of the basin now escapes to the north was made by a tributary of Cumberland River eroding headward.

This tributary captured the waters of the basin that once went through Cumberland Gap.

When the drainage was through Cumberland Gap this gap was the local base-level for the basin. At present the bottom of the gorge at Rocky Face Mountain is a local base-level which causes the valley above this gorge to retain its basin characteristics.

The Canyon of Yellow Creek at the south end of Rocky Face Mountain is near the crest of the warped Cretaceous peneplain. It was here that the lower part of Yellow Creek by headward erosion cut through the divide and captured the river that was on the south side of the crest of the peneplain. The upper part of the canyon is the place of this capture. The canyon is also in hard sandstone.

The meanders that are east of the south end of Rocky Face Mountain are north of the crest line of the Cretaceous peneplain. A stream was meandering in this course before the peneplain was uplifted. After the uplift of the peneplain the stream intrenched the meanders in the hard sandstone.

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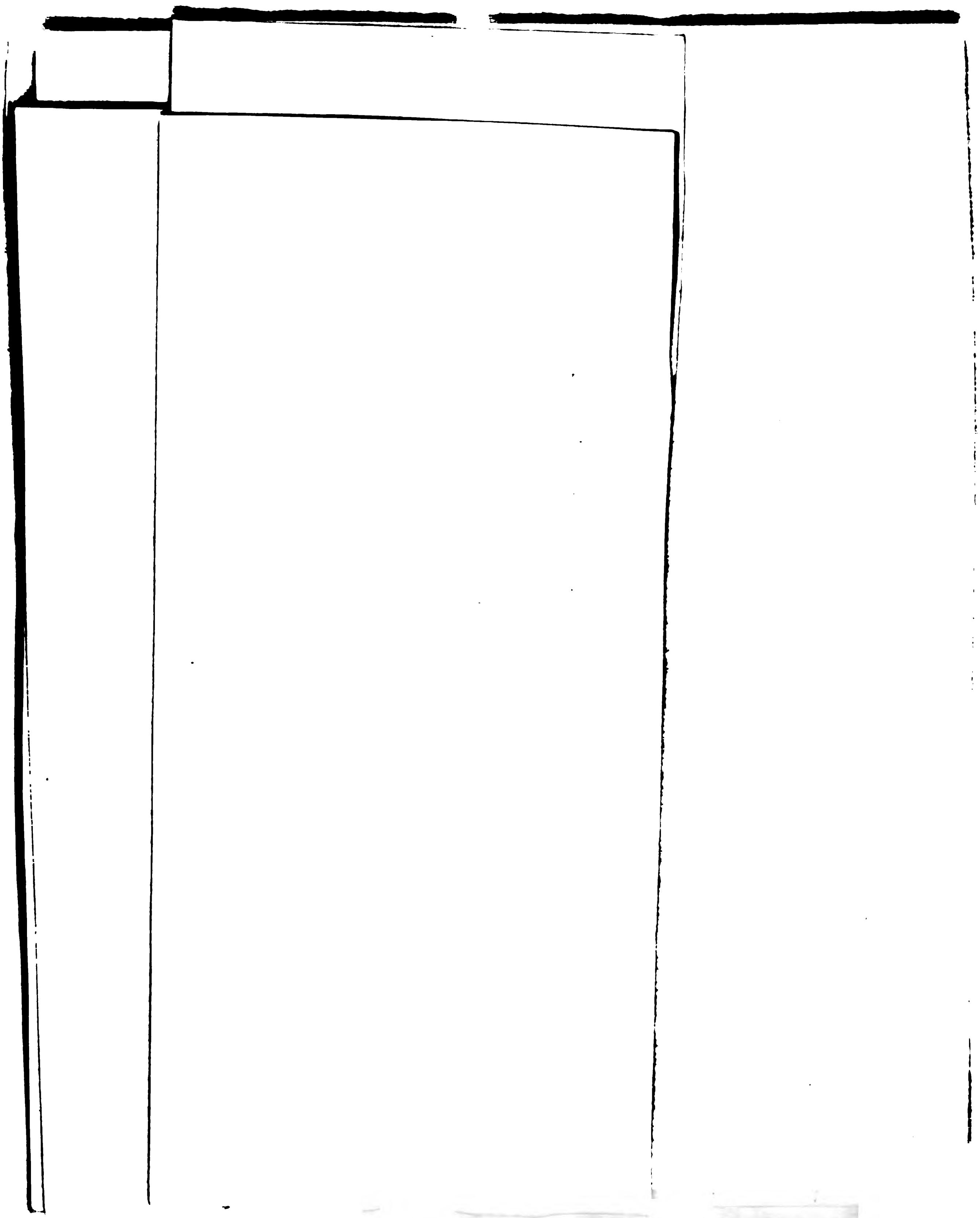

FIGURE 1

FIGURE 3

FIGURE 4

These Pictures Show a Part of the
Present Floor of the Middlesboro Basin.

FIGURE 5

CUMBERLAND GAP

2 mi. away.

IIC MAP OF THE UNITED STATES

s, and the sea by blue
streams, however, which
' of the year, their beds
, are shown, not by full
ots and dashes. Ponds
irt of the year are shown
. Salt-water marshes are
iling interspersed with
ater marshes and swamps
n horizontal lines.
contour lines in *brown.*
ough points which have
ie who follows a con-
l go neither uphill nor
By the use of contours
of the plains, hills, and
so the elevations. The
f is a contour line, the
on being mean sea level.
20 feet above sea level
the seacoast if the sea
to sink 20 feet. Such a
leys and forward around
ours. On a gentle slope
m the present coast line
it is near it. Thus a
ir lines far apart on the
ope; if close together, a
run together in one line,
vertically under the one
cliff. In many parts of
ons or hollows with no
course surround these,
s. Those small hollows
y indicated by hachures,

are also given, the number in each case being placed in close proximity to the point to which it applies.

The works of man are shown in *black*, in which color all lettering also is printed. Boundaries, such as State, county, city, land-grant, reservation, etc., are shown by broken lines of different kinds and weights. Cities are indicated by black blocks, representing the built-up portions, and country houses by small black squares. Roads are shown by fine double lines (full for the better roads, dotted for the inferior ones), trails by single dotted lines, and railroads by full black lines with cross lines. Other cultural features are represented by conventions which are easily understood.

The sheets composing the topographic atlas are designated by the name of a principal town or of some prominent natural feature within the district, and the names of adjoining published sheets are printed on the margins. The sheets are sold at five cents each when fewer than 100 copies are purchased, but when they are ordered in lots of 100 or more copies, whether of the same sheet or of different sheets, the price is two cents each.

The topographic map is the base on which the facts of geology and the mineral resources of a quadrangle are represented. The topographic and geologic maps of a quadrangle are finally bound together, accompanied by a description of the district, to form a folio of the Geologic Atlas of the United States. The folios are sold at twenty-five cents each, except such as are unusually comprehensive, which are priced accordingly.

Applications for the separate topographic

FIGURE 6

Jonesville Quadrangle, showing Pennington Gap.

FIGURE 7

Detailed Map of the Cumberland Gap Area.


MAP
of the
SOUTHERN APPALACHIANS
showing the deformed
CRETACEOUS PENEPLAIN
Scale
Miles
0
50
100
90
86
82
78
36
32
A
B
C
D
E
E'
G
H
O
P
1400
1000

FIG 8

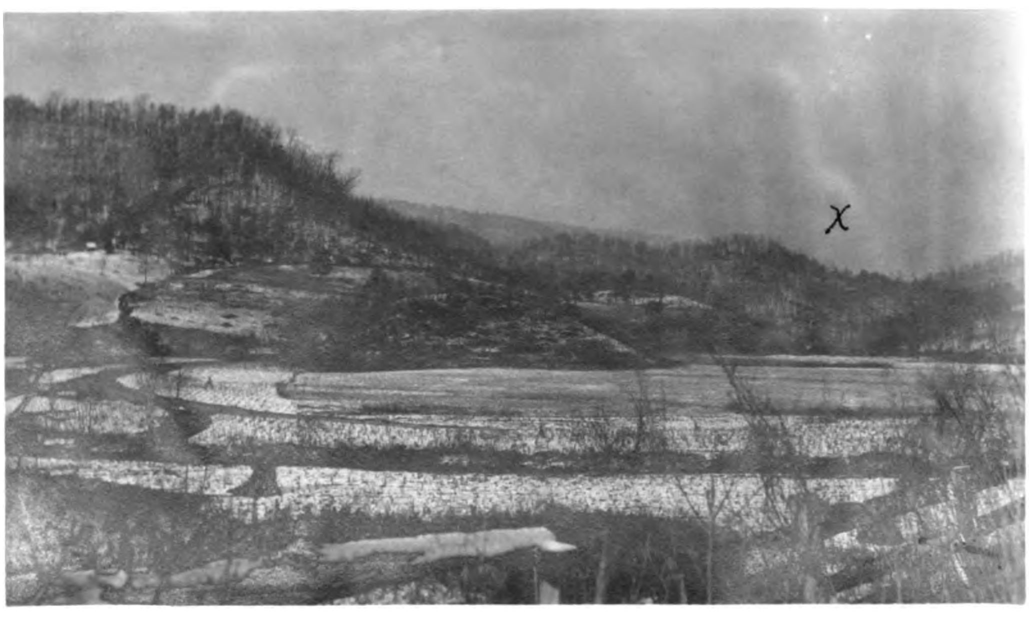

FIGURE 9

X is Cumberland Gap. In foreground is Middlesboro Basin. Hills in central part of Basin are low; get higher

MAP OF YELLOW CREEK when it flowed through CUMBERLAND GAP.

FIGURE 10

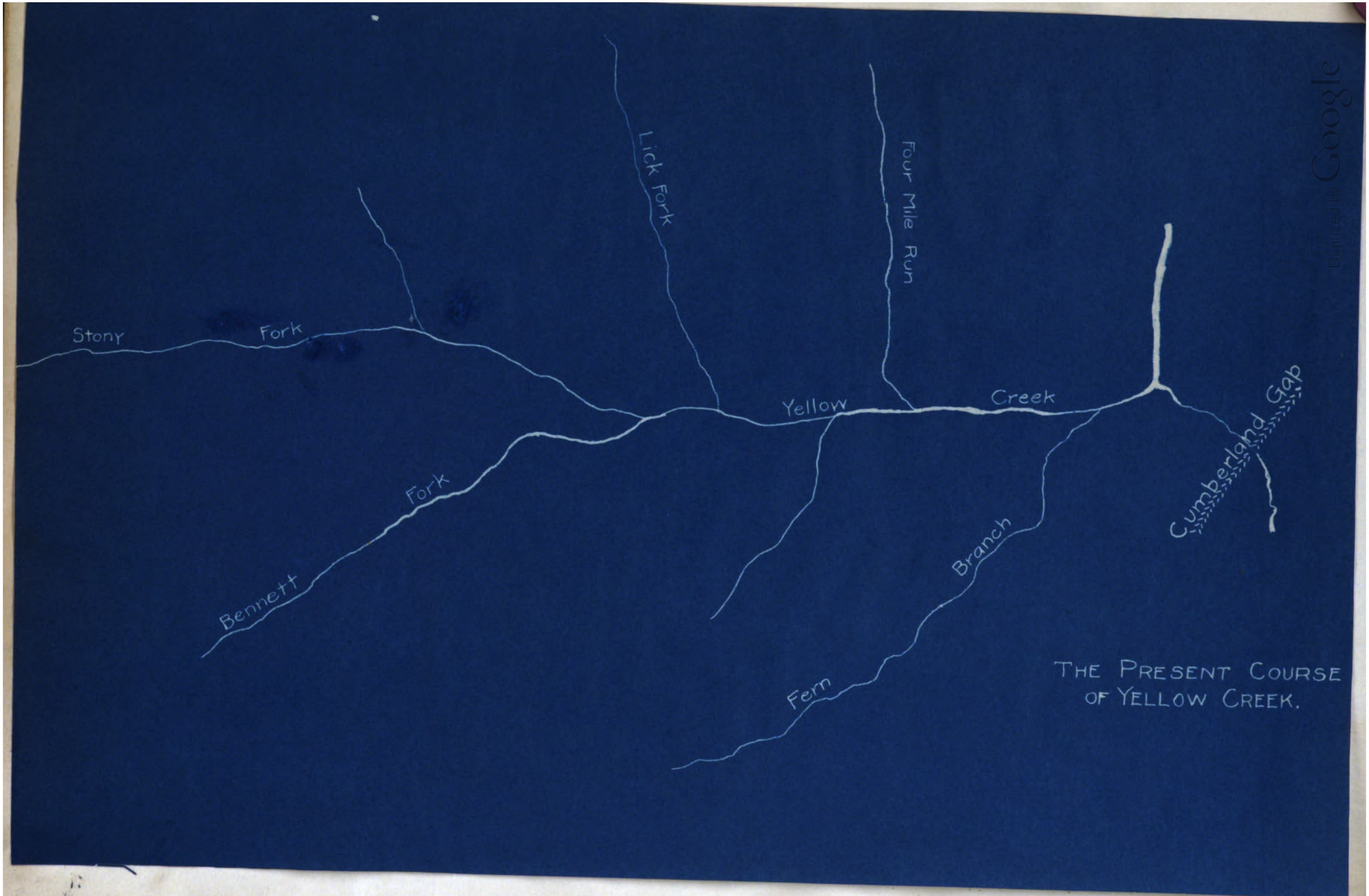
Stony Fork
Lick Fork
Four Mile Run
Yellow Creek
Bennett Fork
Branch
Fern
Cumberland Gap
THE PRESENT COURSE
OF YELLOW CREEK.

FIGURE 11

FIGURE 12

Middlesboro Basin where a tributary enters.

FIGURE 13

A portion of Middlesboro Basin where no tributary enters.

APPROVED:

Lawrence Martin

Associate Professor of Physiography
and Geography.

June 3, 1915.